

A photograph of a large, multi-story building with a red-tiled roof and arched windows, likely a Stanford University building. The building is surrounded by greenery and a lawn. The text is overlaid on the image.

Distributed Source Coding with Unsupervised Statistical Learning

Learning Motion in Distributed Video Coding

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“Despite recent advances, distributed video coding rate-distortion performance is not yet at the level of predictive coding. The critical steps with respect to rate-distortion performance are:

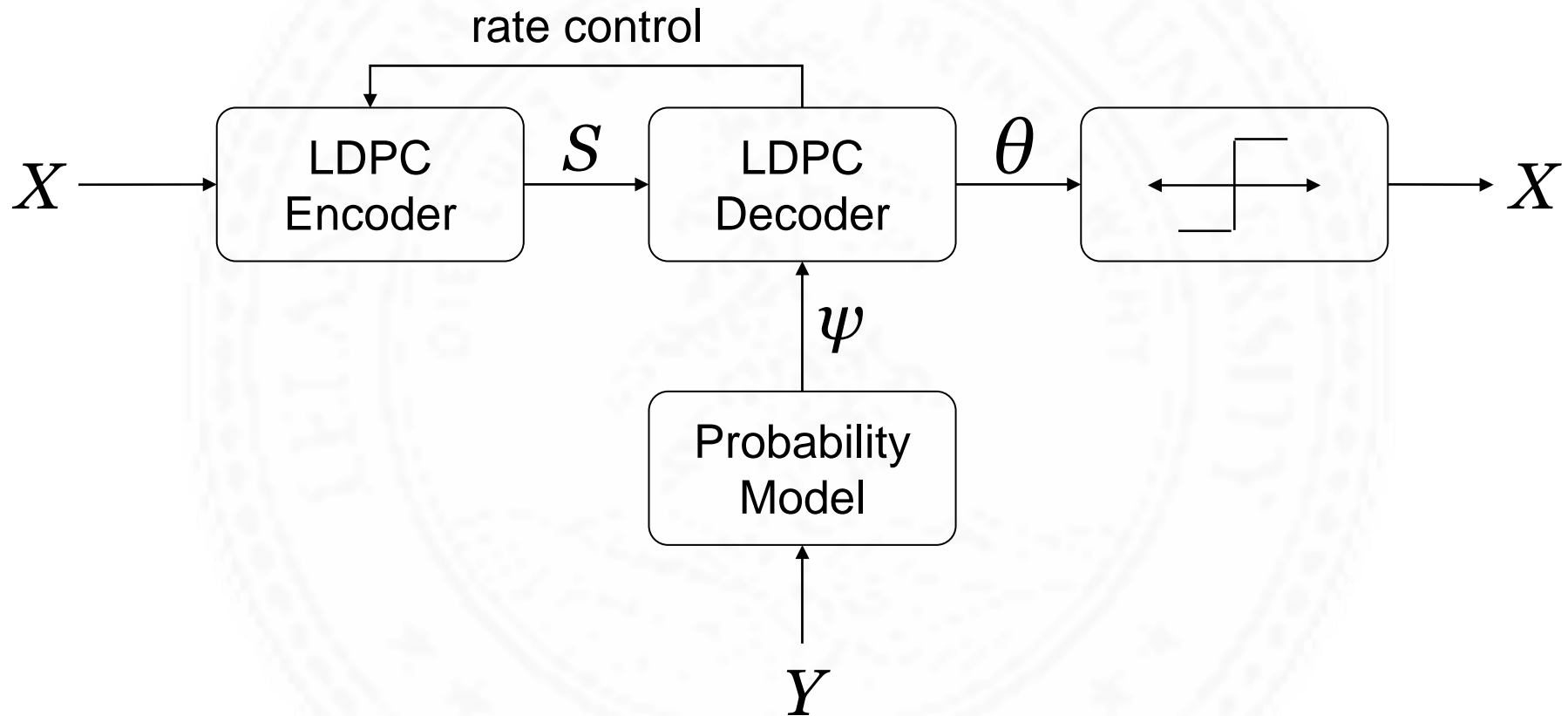
- 1. finding the best side information (or predictor) at the decoder and*
- 2. accurately modeling and estimating the correlation channel.”*

[Guillemot, Pereira, Torres, Ebrahimi, Leonardi, Ostermann, 2007]

Outline

- Background on Slepian-Wolf coding with LDPC codes
- Lossless distributed video coding with motion oracle
- Lossless distributed video coding with motion learning
- Extension to Wyner-Ziv video coding
- Wyner-Ziv coding results

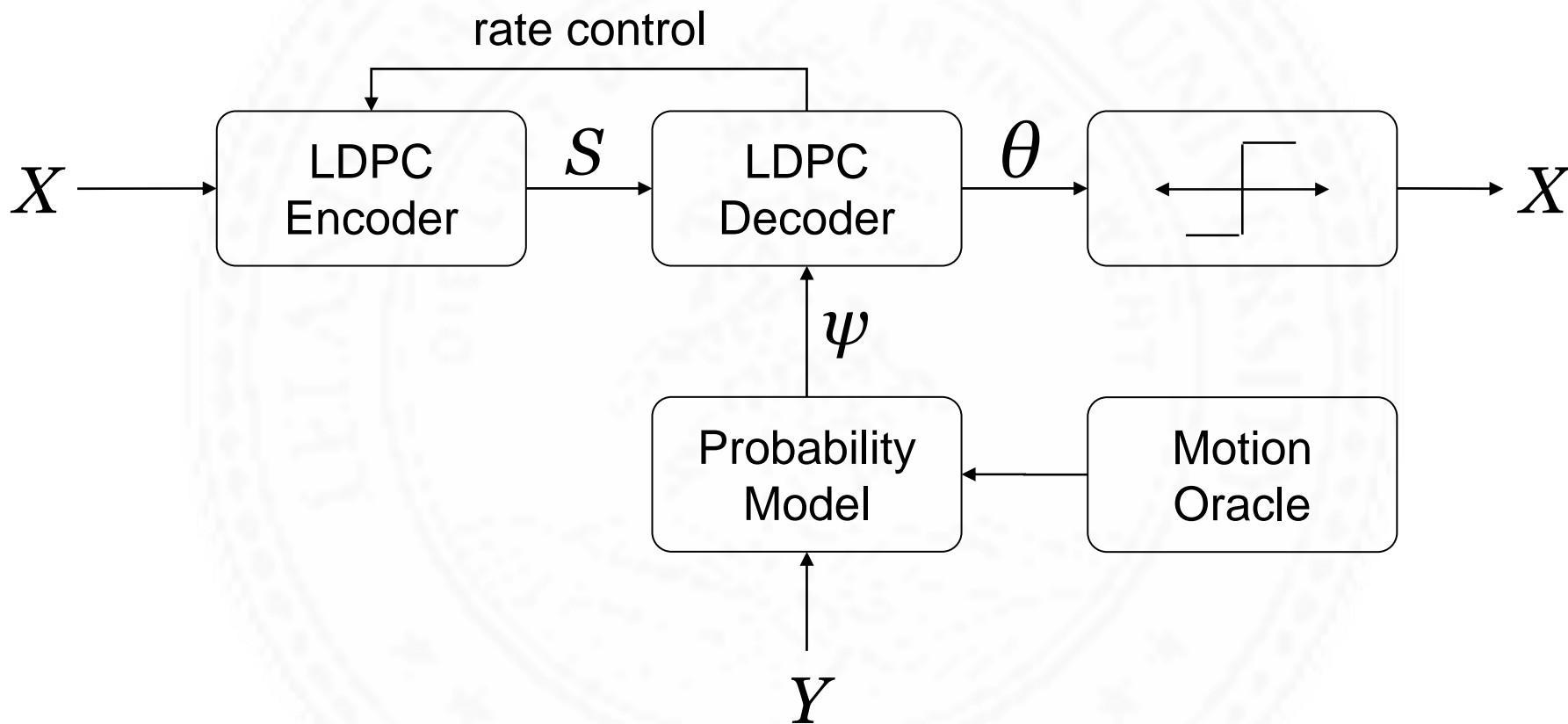
Slepian-Wolf Coding with LDPC Codes



[Varodayan, Aaron, Girod, 2005]

<http://www.stanford.edu/~divad/software.html>

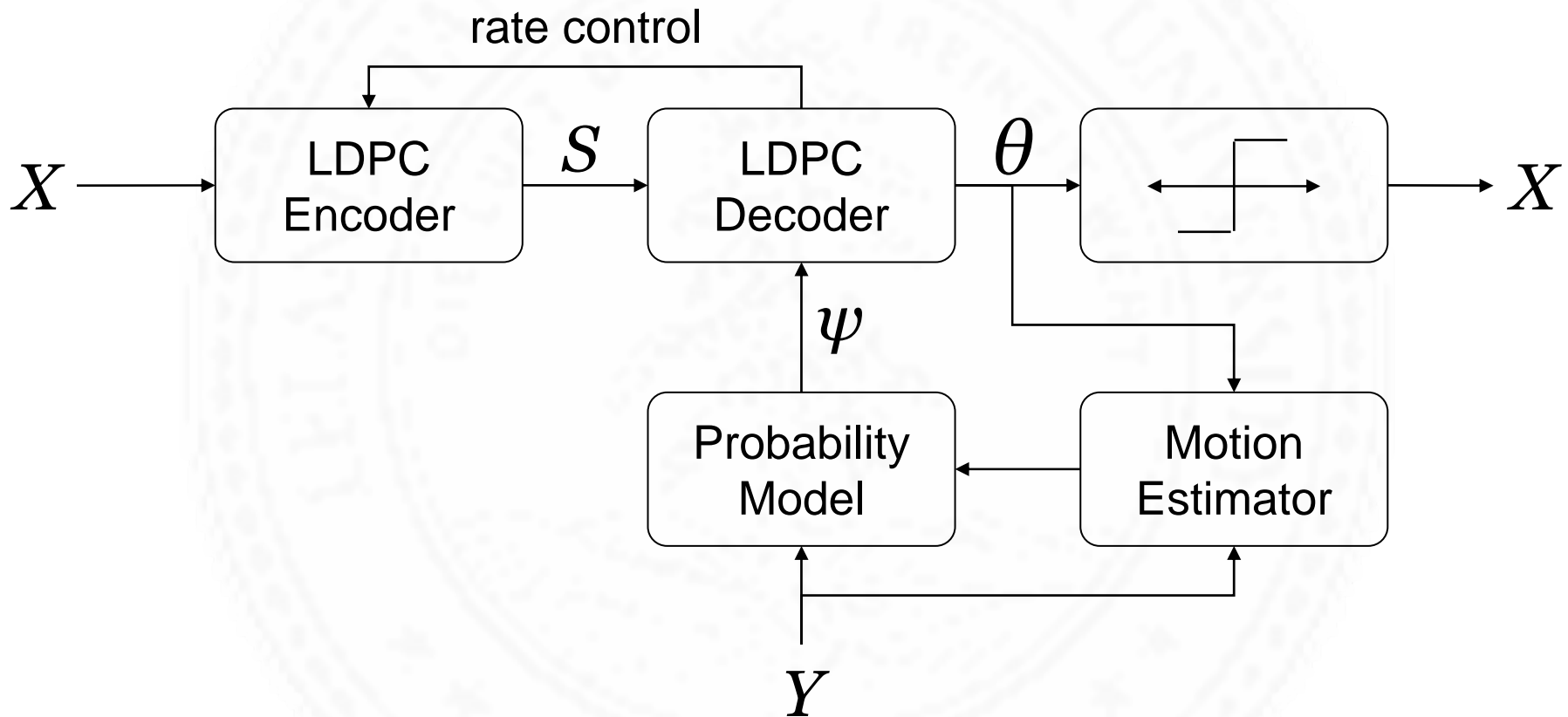
Oracle-Assisted Decoder



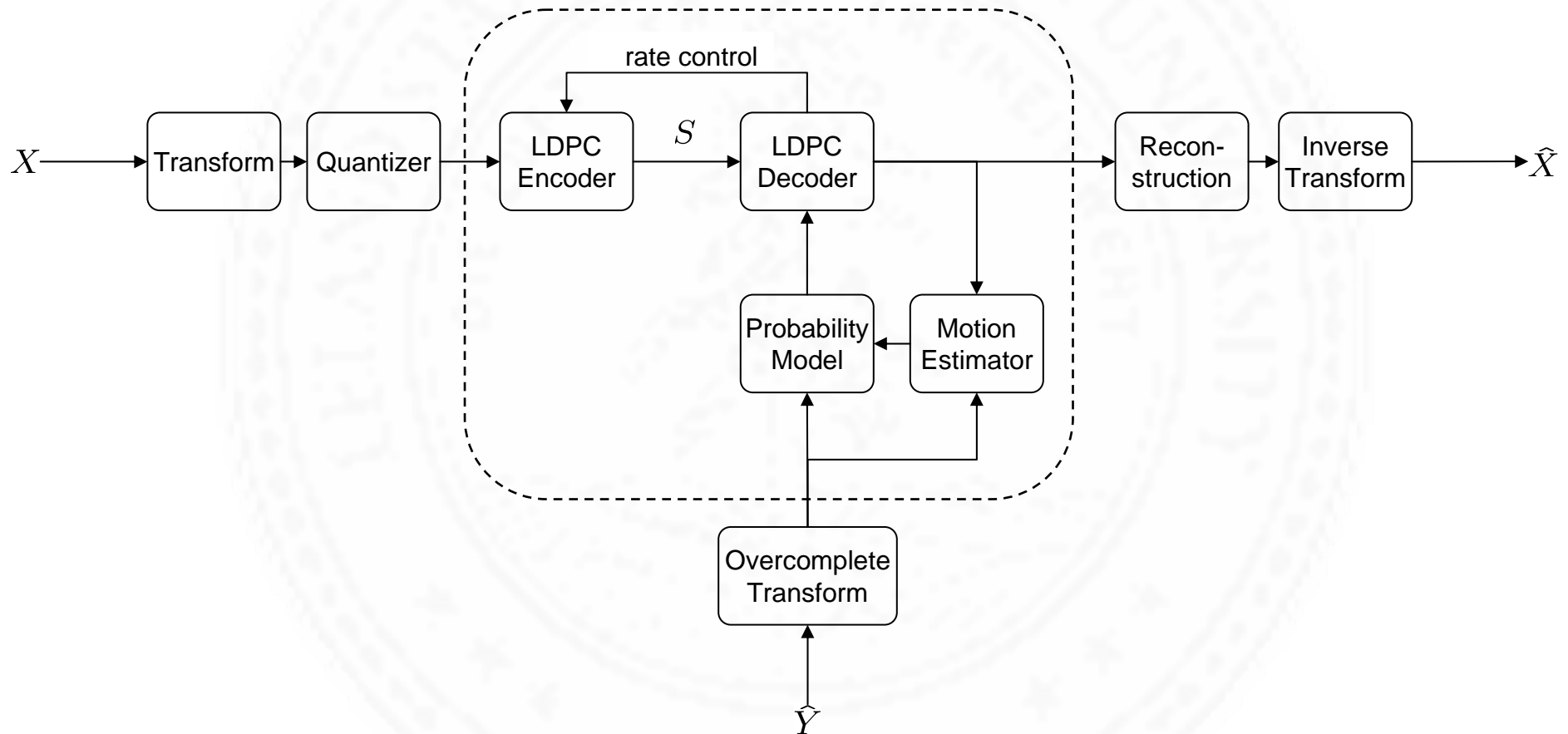
Review of Motion Estimation Techniques

- Motion interpolation/extrapolation from keyframes
 - [Aaron, Zhang, Girod, 2002]
 - [Natário, Brites, Ascenso, Pereira, 2005]
 - ...
- Motion search using blockwise hashes
 - [Puri, Ramchandran, 2002]
 - [Aaron, Rane, Girod, 2004]
 - ...

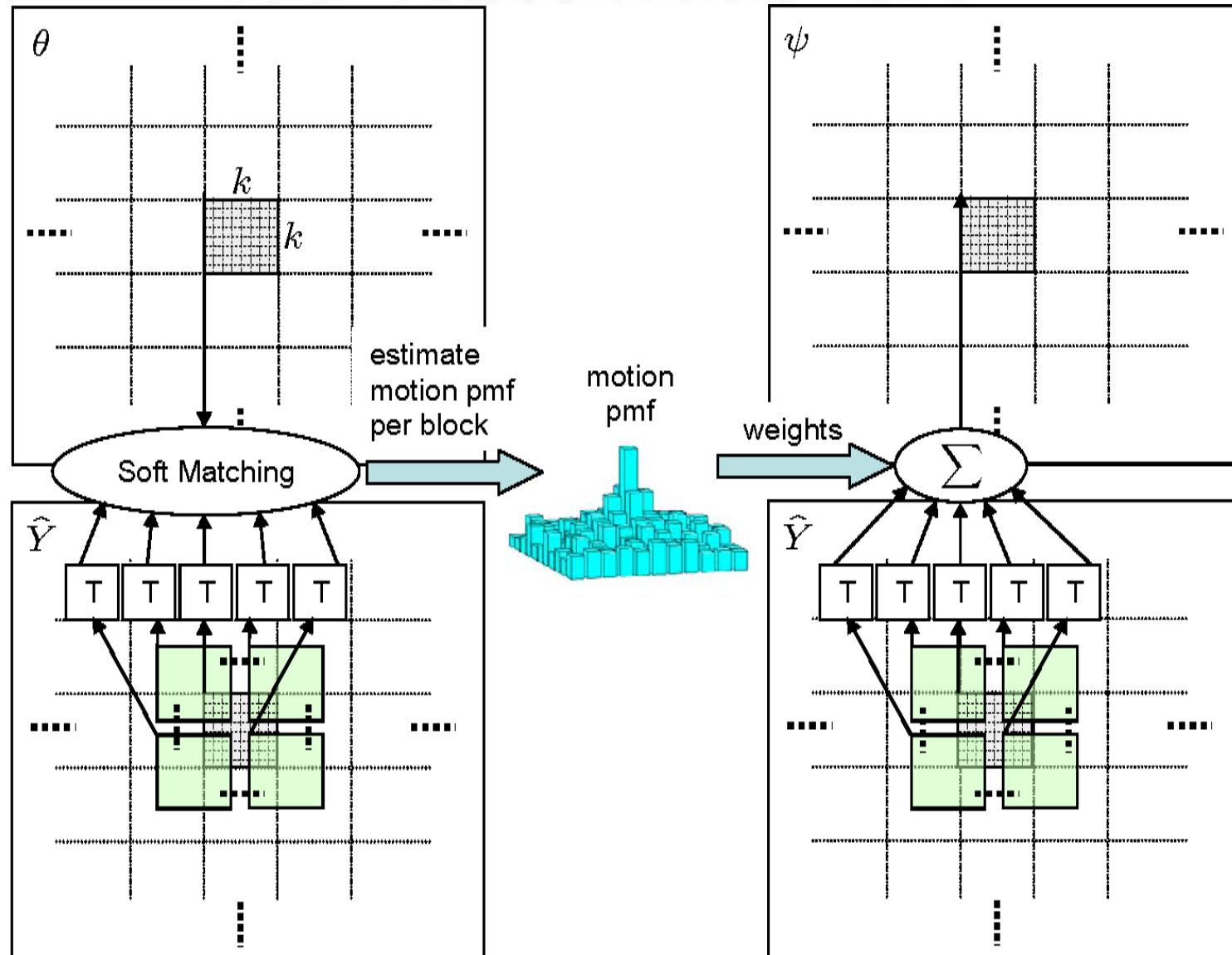
Unsupervised Motion Learning at Decoder



Extension to Wyner-Ziv Coding



Motion Estimation and Probability Modeling

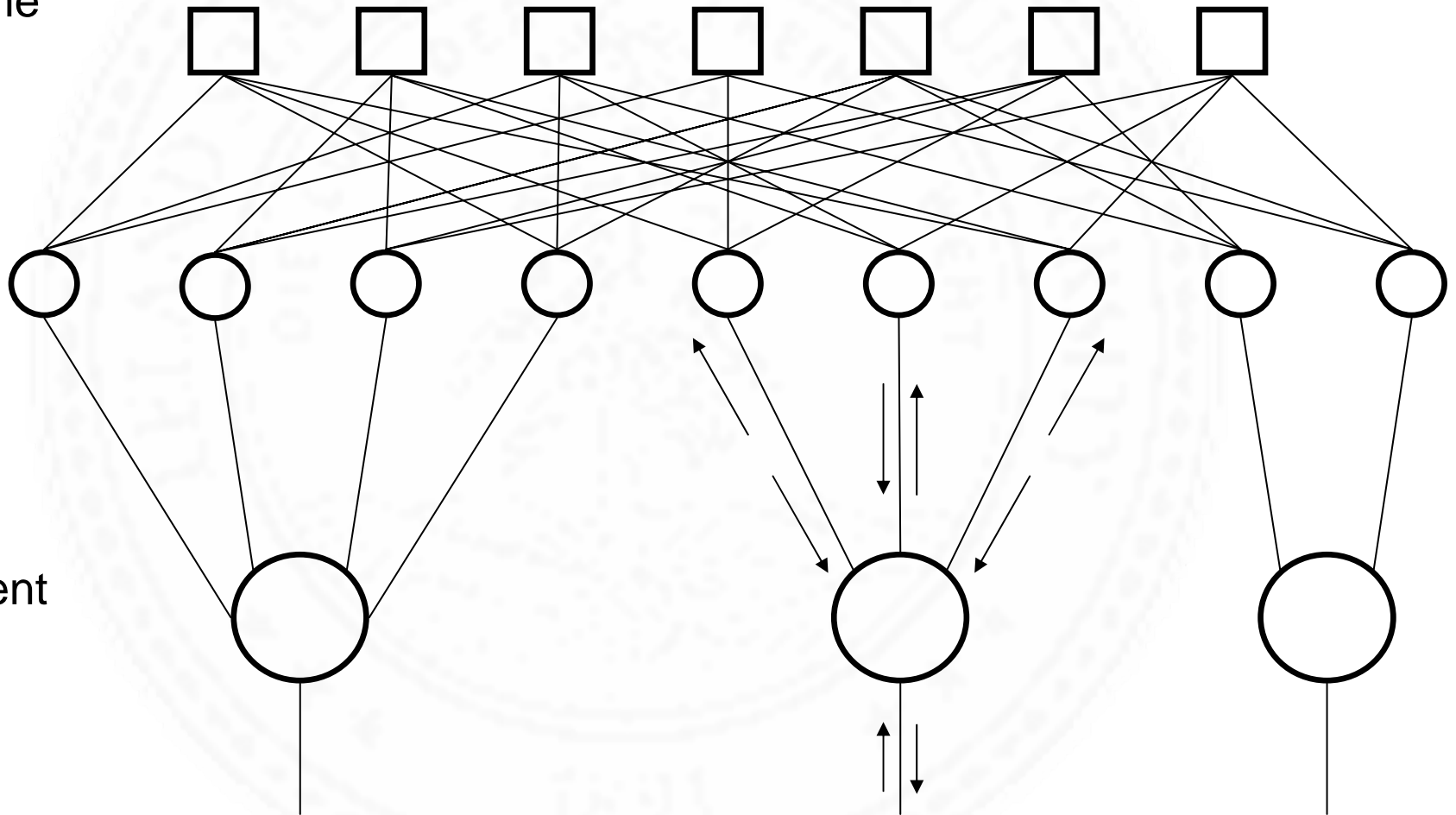


Joint Bitplane Decoding

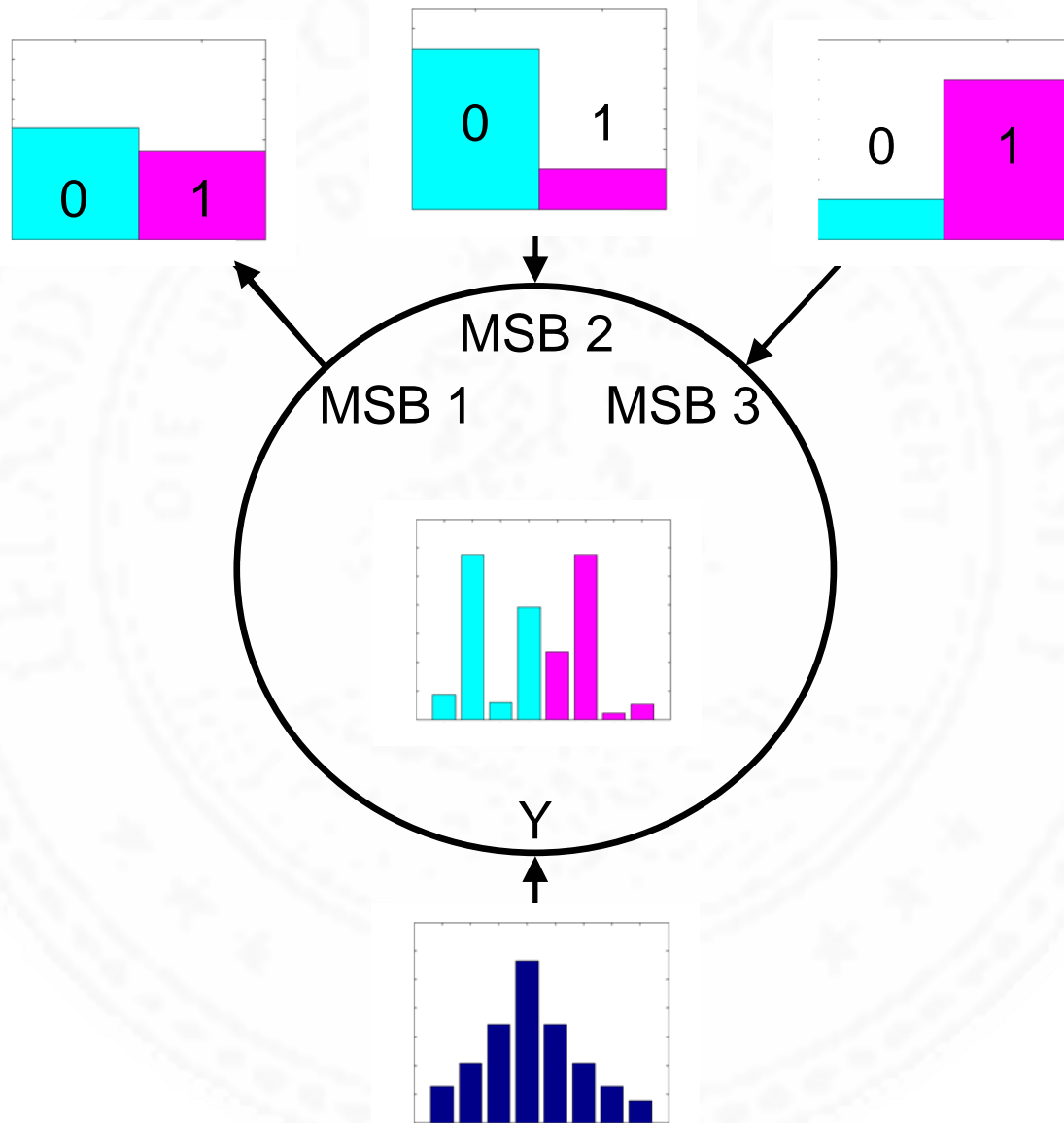
Syndrome
Nodes

Bit
Nodes

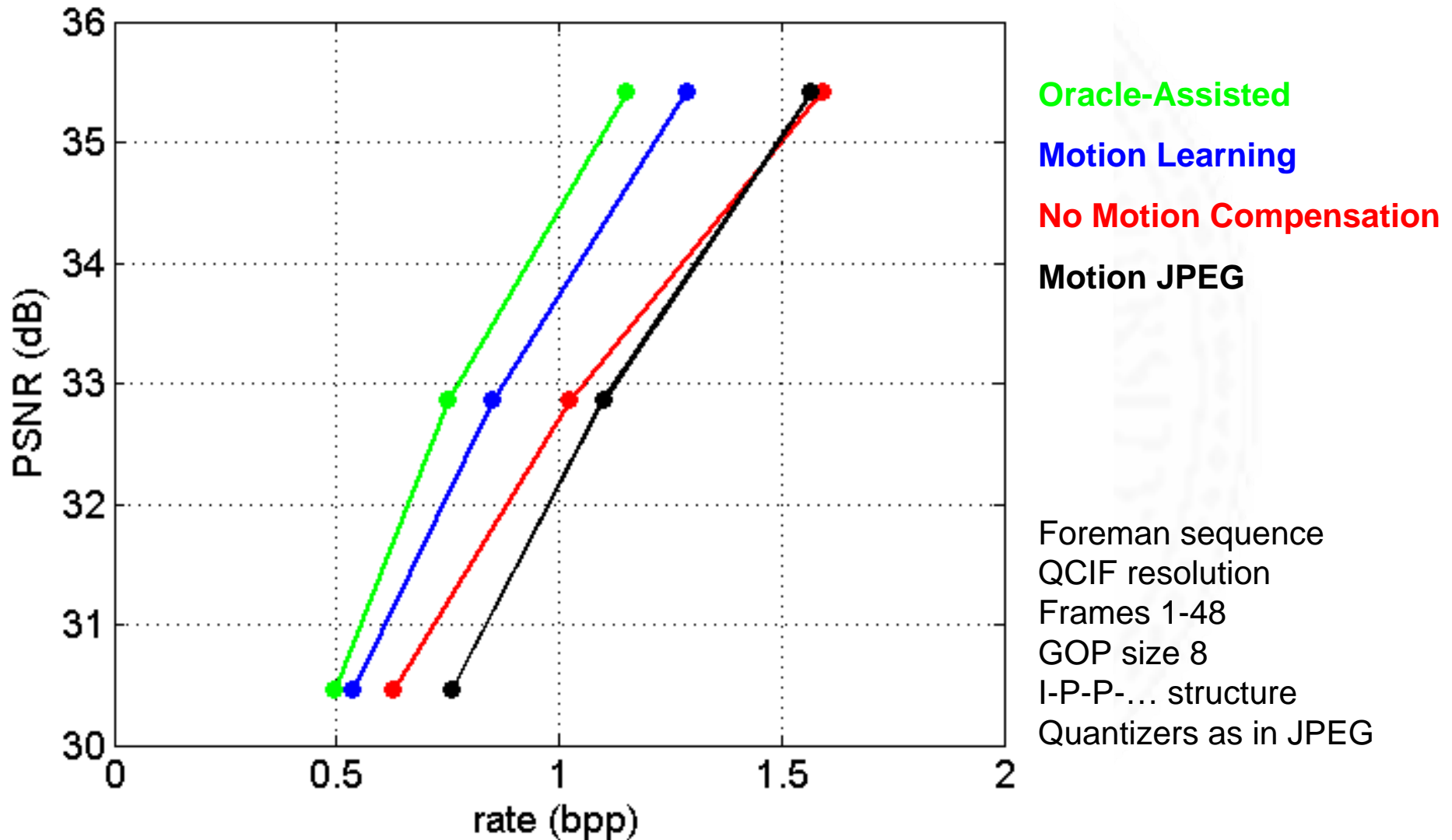
Coefficient
Nodes



Coefficient Node Computation Example



Wyner-Ziv Coding Results



Conclusions

- Expectation-Maximization framework for joint decoding and motion learning in DVC decoder
 - Motion estimation using Slepian-Wolf coded bitstream
 - Motion estimation lies within LDPC decoding loop
 - Joint bitplane LDPC decoding enables motion estimation at quantization coefficient level
- Research needed to see exactly how unsupervised statistical learning should be applied to DVC
- C code to be posted online by end of 2007

<http://www.stanford.edu/~dmchen/>